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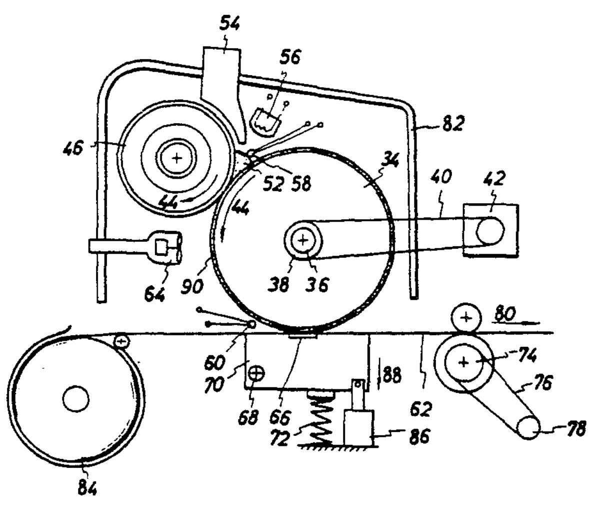
(54) **Thermal printing device.**

(57) A thermal printing device is disclosed which prints on ordinary paper using an ink which melts when heated but is solid at room temperature.

The device comprises an ink-carrier with an even outer surface which rotates to carry an ink-layer formed on said surface from an ink-source to a printing position. A cylindrical roller with an uneven surface in directions parallel to the axis of the roller is in contact with the ink-carrier along spaced lines lying in planes normal to the axis of the roller with the ink-source between the ink-carrier and the cylindrical roller. The ink of ink-source is melted and adheres to the surface of the ink-carrier in an ink-layer as the ink-carrier rotates. Means are provided at the printing position for generating thermal patterns to re-melt the solid ink-layer by generating thermal patterns in accordance with printing signals. Printing paper is fed to the printing position where the paper is forced into contact with the ink-carrier so that ink patterns are transcribed onto the printing paper.



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THERMAL PRINTING DEVICE

The invention relates generally to a thermal printing device of the kind for printing on ordinary paper using an ink which melts when heated but which is solid at room temperatures, and comprising an ink-carrier having an outer surface for carrying an ink-layer on said surface from a source of ink to a printing position, a cylindrical roller in contact with said outer surface to form a location for said source of ink therebetween, means for melting the ink in the source of ink, means for moving the ink-carrier, so that the melted ink forms an ink-layer on the ink-carrier, thermal pattern generating means at said printing position for remelting a solid ink-layer on the surface of the ink-carrier by generating thermal patterns in accordance with printing signals fed thereto, and printing paper control means for controlling the feeding of printing paper and for forcing the printing paper into contact with the ink-carrier so that ink patterns produced by the thermal pattern generating means are transcribed onto the printing paper.

Various kinds of printing device are used for data processing in computers, facsimile and copying machines. Efforts have been made to improve such devices in respect of their dimensions, printing speeds, noise levels and electric consumption. Printing devices may be classified into two kinds, impact-type printers which effect printing by mechanical impacts and non-impact-types without such mechanical impacts. Although impact-type printers have some advantages, the use of non-impact-types have developed in recent years, because of their low noise and absence of printing elements.

Non-impact-type printers may be further classified into inkject-type printers, electrostatic-type printers and thermal printers. Inkject-type printers spout liquid ink in the form of minute ink drops from a nozzle and the ink drops adhere onto printing paper as dots to effect printing.

Electrostatic printers comprise a drum which can be charged electrostatically. Tonar, i.e. a particle ink, is adhered onto the drum and is transcribed and fixed onto the printing paper to effect printing. A thermal printer effects printing by using an ink-layer of heat-melting ink which can easily be transcribed onto the printing paper.

A characteristic advantage of these non-impact-type printers is that an ordinary paper can be used for printing. This ordinary paper, since it requires no specific processing, can easily be furnished.

Inkject-type printers have the disadvantage that the nozzle is frequently choked and thus it is difficult to effect steady printing over a long period of time. It is necessary for an electrostatic printer to fix the electrostatic image after transcribing the charged particles and so a fixing device is indispensable. For this reason, such printers tend to be large and be expensive. In contrast, thermal printers have no such disadvantages.

Fig. 1 of the accompanying drawings shows a prior art thermal printing device comprising an ink-roller 10 on the surface of which a minute uneveness is formed by foam-rubber or fibres.

A reforming roller 12 is provided which is in the form of a metal rod and the ink-roller 10 and the reforming roller 12 rotate in the direction of an arrow 14 in contact with each other.

The reforming roller 12 is heated by a heater 16 which is spaced from the roller 12 to melt the ink in an ink pool 18 between the ink-roller 10 and the roller 12.

The ink is a mixture of coloured particles, a printing medium, such as a paraffin compound, and dispersion elements. The ink is solid at room temperatures, but it melts rapidly when heated above a predetermined temperature and flows freely. The melted medium, i.e. the paraffin compound, can soak into ordinary paper. The melted ink permeates into and adheres to the uneveness on the surface of ink-roller 10 and solidifies into an ink-layer 20 on cooling. A thermal head 22 is provided with numerous minute heat elements inside. The thermal head 22 is pressed toward the ink-roller 10 together with a printing paper 26 with the aid of spring means 24 at a pressure of 200 to 1,000 gram/cm^2.

A paper feed roller 28 and a pulse motor 30 for driving the paper feed roller 28 are also provided.

In operation, the heat elements of the thermal head 22 generate heat when printing signals are fed to the thermal head 22, thus melting the ink-layer 18 on the ink-roller 10 from the rear side of the printing paper 26.

The melting ink is then transcribed onto the surface of the printing paper 26 as a series of dots. After printing dots on the paper 26, the paper feed roller 28 is driven by the pulse motor 30 to feed the paper 26 in the direction of the arrow 32 by steps for successively printing dots on the paper 26. The ink-roller 10 is rotated in the direction of the arrow 14 by the frictional force of the paper 26 when the paper 26 is fed in the direction of the arrow 32. The surface of ink-roller 10 needs to be re-inked by the supply of ink from the ink-pool 18, because uneveness of ink-layer 20 occurs after printing dots on the paper 26.

In the above-described thermal printing device, the dominant factors which decides printing quality are the eveness of the ink-layer and the timely solidification and melting of the ink. It is difficult to flatten the ink-layer, because the ink roller on which the ink-layer is formed has an uneven surface. Accordingly, the ink-layer is slightly uneven and does not uniformly contact the thermal head, and so the heat is not well conducted to the ink-layer from the thermal head. As a consequence, the ink-layer is not sufficiently melted, consequently the ink is not properly transcribed onto the printing paper and the printing quality is degraded. The printing quality becomes worse if the solidification and melting of ink are not adequate leading to a lack of dots and spotted paper.

The ink-roller is the most important factor in obtaining a flat ink-layer. Accordingly, the surface of ink-roller should be polished or should have numerous minute dents distributed uniformly all over the surface. Such forming, however, requires precision techniques and costs time and effort. If the surface is polished, the thickness of the ink-layer is reduced, because the ink-roller is then in close contact with the reforming roller.

According to our experiments, the most suitable thickness of the ink-layer is about 20 to 35 microns. The thickness of ink-layer obtained by a combination of a rubber ink-roller and reforming roller is less than 10 microns, and is thus insufficient for printing. Furthermore, it is almost impossible to increase the thickness of ink-layer by providing a gap between the ink-roller and reforming roller due to the difficulty of producing an even thickness. There are also other problems to be solved in order to solidify and melt the ink, such as the distance between from the ink-pool and the printing position and the provision of means for melting the ink.

Accordingly, it is an object of the present invention to provide a thermal printing device of improved printing quality and to provide a level ink-layer.

Accordingly, the invention is characterised in that the outer surface of the ink-carrier is even, that the cylindrical roller has an uneven outer surface in directions parallel to the axis of the roller and in that said uneven outer surface contacts the outer surface of the ink-carrier along lines spaced apart across the width of the roller.

The following is a more detailed description of some embodiments of the invention, by way of example, reference being made to the accompanying drawings, in which:-

Fig. 1 is a schematic side elevation of a prior art thermal printing device;

Fig. 2 is a schematic side elevation of an embodiment of a thermal printing device according to the invention;

Fig. 3 is a cross-sectional view of a part of the device of Fig. 2;

Fig. 4 is a partial side elevation of a second embodiment of a thermal printing device according to the present invention;

Fig. 5 is a schematic side elevation of a third embodiment of a thermal printing device according to the invention and employing an ink-belt;

Fig. 6 is a partial cross-sectional view of an example of the ink-belt of Fig. 5;

Fig. 7 is a schematic side elevation of a further embodiment of a thermal printing device according to the invention and in which a laster beam is employed for generating thermal patterns;

Fig. 8 is a schematic perspective view of a scanning means of the embodiment of Fig. 7;

Fig. 9 is a schematic side elevation showing yet a further embodiment of a thermal printing device according to the invention;

Fig. 10 is a schematic perspective view of an embodiment of a thermal printing device according to the invention and in which means for generating thermal patterns is provided inside the ink-roller;

Fig. 11 is a schematic side elevation showing an embodiment of a thermal printing device according to the invention and in which means for generating thermal patterns are provided outside the ink-belt; and

Fig. 12 is a schematic side elevation showing an embodiment of a thermal printing device according to the invention in which means for generating thermal patterns are provided inside the ink-belt.

Referring first to Fig. 2, the device shown in this Figure comprises an ink-roller 34 for carrying ink and made of a heat-proof elastic material such as silicone rubber or neoprene rubber. The ink-roller 34 is supported for rotation about an axis 36 by a drive motor 46 through a one-way clutch 38 and a belt 40. The motor 42 rotates the ink-roller 34 in the direction of the arrow 44 in Fig. 2. A reforming roller 46 is provided which has a cylindrical surface on which an ink-layer 90 is formed when the reforming roller 46 comes in contact with the ink-roller 34.

As shown in more detail in Fig. 3, a fine wire 48 is wound around the reforming roller 46, the coils of the wire 48 being in close contact with each other. Preferably, the wire 48 is about 150 -- 250 microns in diameter in order to obtain an ink-layer 90 of about 20 -- 35 microns in thickness. An electrical resistance wire 50, such as nichrome wire, is provided inside the reforming roller 46 to generate heat on the passage through the wire 50 of an electric current from an electric voltage source (not shown) to warm the ink of an ink-molten pool 52. The reforming roller 46 is constantly in contact with the ink-roller 34 at a pressure of 200 -- 1,000 gram/cm^2 and is rotatably supported. The reforming roller 46 is rotated by the ink-roller 34 when the roller 34 is rotated in the direction of the arrow 44 by the drive motor 42. An ink-supplier 54 is provided for supplying ink to the ink-molten pool 52 which is held between the ink-roller 34 and the reforming roller 46.

The ink-molten pool 52 is heated by heating means 56 such as an electric heater, lamp or hot air. The ink-molten pool 52 is also heated by the electric resistance wire 50 of reforming roller 46 and the temperature of the ink-molten pool 52 is controlled by measuring it with a heat sensor 58. A heat sensor 60 is provided for measuring the temperature of the ink-roller 34 and is located adjacent to the ink-roller 34 near a printing paper 62. A fan 64 for cooling the ink-roller 34 is situated in front of the ink-roller 34. A thermal head 66 for generating thermal patterns is situated on a base 70 which is supported by a rotatable supporting pivot 68. The base 70 is pressed toward the ink-roller 34 by a spring 72, thus pressing the thermal head and the printing paper 62 against the ink-roller 34. A paper feed roller 74 is drivably connected to a pulse motor 78 by way of a belt 76 and the printing paper 62 is forwarded in the direction of the arrow 80. Also provided are a dust cover 82, stock means 84 for holding a supply of printing paper 62 and suction means 86 by which the base 86 can be moved in the direction of an arrow 88.

In operation, the electric resistance wire 50 generates heat when the electric voltage is applied to the wire 50 and thus the ink-molten pool 52 is heated. Even when electric voltage is applied to the reforming roller 46, the thermal head 66 is still pulled in the direction of an arrow 88 by suction means 86, as long as a printing signal is not fed to the thermal head 66 for generating heat patterns. Accordingly, the thermal head 66 is spaced from the ink-roller 34. When electric voltage is first applied to the electric resistance wire 50, it takes a considerable time to melt completely the ink in the ink-molten pool 52, because the amount of heat generated is small. In order to shorten this warming-up time, the temperature of ink-molten pool 52 is sensed by sensor 58 and the heater 56 may be activated if the temperature is below the melting point of ink. Thus, the ink is heated to melt it completely. Once the ink is sufficiently melted, the heater 56 is turned-off and the ink is then heated only by the reforming roller 46 and remains melted. The ink-roller 34 is rotated in the direction of arrow 44 by drive motor 42 during the warming-up time, and the reforming roller 46 also rotates, due to its contact with the ink-roller 34, in the direction of the arrow 44.

The ink in ink-molten pool 52 adheres onto the surface of ink-roller 34, with the aid of reforming roller 46, to form an ink-layer 90 which will be described in more detail hereinunder.

The process of forming the ink-layer 90 will be described with reference to Fig. 3. This figure shows how the ink-layer 90 is formed on the surface of ink-roller 34 with the aid of the reforming roller 46 with the electric resistance wire wound inside this roller and also spirally wound wire 48 wound outside this roller. Adjacent wires 48-1 and 48-2 are in contact with the ink-roller 34 of elastic material. A gap for the ink-pool is formed between the ink-roller 34 and spirally wound wires 48-1, 48-2, notwithstanding the fact that the ink-roller 34 is in contact with reforming roller 46, because of the round cross-section of these wires 48-1, 48-2. In other words, an uneveness is formed on the surface of reforming roller 46 in directions parallel to the roller axis, because the wire 48 is wound round the surface and the wire 48 is in line contact with the ink-roller 34. The ink of the ink-molten pool 52 permeates into the gaps and some of it adheres onto the surface of ink-roller 34 and wire 48. Almost all the ink, however, adheres onto the ink-roller 34, because the temperature of reforming roller, which has the heat element inside is higher than that of the ink-roller 34.

The ink adhered onto the ink-roller 34 flows together, after leaving wires 48-1, 48-2, as the ink-roller 34 rotates, and joins with ink which has already adhered onto the ink-roller 34 due to surface tension effects. This process is repeated along the axial length of the ink-roller, thus forming a level ink-layer 90 of desired thickness. The thickness of ink-layer 90 depends on the quantity of ink which permeates into the vacant portions between the ink-roller 34 and wires 48-1, 48-2, so an optimum thickness can be obtained by varying the diameter of the wire 48. The optimum thickness of ink-layer 90 may be 20 -- 35 microns, and in this case the recommended diameter of the wire 48 is about 150 -- 250 microns. An insulator 92, Fig. 3, is provided in case the reforming roller 46 is made of a conducting material such as a metal.

A printing signal or predicting signal is fed to the thermal printing device after formation of the ink-layer 90 on the surface of the ink-roller 34. The drive motor 42 is then stopped, thereby stopping the rotation of ink-roller 34. Simultaneously, the suction means 86 is rendered inoperative so that the thermal head 66 is pressed, with the printing paper 62, against the ink-roller 34 by the spring 72 at a pressure of 200 -- 1,000 gram/cm^2. The thermal head 66 is turned on by the printing signal.

The thermal head comprises a set of electric resistance elements which generate heat by applied electric voltages and the ink-layer 90 is heated by the heat. The heated ink melts and is transcribed in dots onto the surface of printing paper 62.

The transcribed ink dissipates its heat in a short period of time and re-solidifies. But, the ink soaks into the printing paper 62 before its re-solidification. After the printing is finished, the pulse motor 78 is driven in synchronism with the transmission of electric voltages to the thermal head 66, thus rotating slightly the paper feed roller 74. Once the paper feed roller 74 rotates, the printing paper 62 is stepped in the direction of the arrow 80 and electric current is retransmitted to the thermal head 66 in order to repeat printing. These steps are repeated in mnay times, thus printing characters or picture elements on ordinary printing paper 62 in dots.

Small depressions will occur in the ink-layer 90 after ink from the ink-layer 90 has been transcribed onto the printing paper 62. Such depressions will cause imperfect contact by the thermal head 66 in the next printing step or irregular printing. Accordingly, it is necessary to remove such small concavities in the ink-layer 90 and to reform a flattened ink-layer 90. The following is a description of such reforming process of the ink-layer 90.

The drive motor 42 for rotating the ink-roller 34 stops when the printing is effected, accordingly, the ink-roller 34 cannot be rotated. The ink-roller 34 however rotates in the direction of arrow 44 with the printing paper 62 due to the friction force of the printing paper 62 on the roller 34, when the paper 62 is fed in the direction of arrow 80 after a printing step has been completed. By repeating such steps, the depressions in the ink-layer 90 will eventually reach the ink-molten pool 52 and be reformed as detailed above. Besides, the reaction force will not effect the rotation of ink-roller 34 in the direction of arrow 44, since the ink-roller 34 comprises the one-way clutch 38.

It is necessary that the ink-layer 90 is solidified when it reaches the position where it comes into contact with the thermal head 66, because the printing quality will be degraded by spotted inks if the ink-layer 90 is not sufficiently solidified. Thus, the temperature of ink-roller 34 is detected by sensor 60 and the fan 64 is activated to cool the ink-layer 90 if the temperature of ink-roller 34 is above the melting point of ink. Thus, the ink-layer 90 solidifies completely before reaching the head 66.

The thermal printing device described above with reference to the drawings can produce a level ink-layer of optimum thickness, as the ink-layer is formed on the surface of ink-roller with the aid of spirally wound wires. The ink-layer solidifies completely and the printing quality is improved, since the temperature of ink-roller is controlled by the cooling fan. Moreover, the warming-up time can be shortened, because the ink in the ink-molten pool is melted by the electric resistance wire inside the reforming roller and the heater. The reforming roller may be polygonally shaped and be fixed. Narrow spaced grooves of fine lines may be formed on the surface of reforming roller in place of the wires.

Referring next to Fig. 4, the embodiment shown has the reforming roller 46 made of a heat-resisting rod such as a metal rod around which an electric resistance wire 94 such as nichrome wire is spirally wound through insulating material. Thus, the electric resistance wire inside the reforming roller 46 can be dispensed with and a flattened ink-layer 90 of optimum thickness still formed. It may be designed to constantly cool the ink-layer by controlling the fan 64 in compliance with the measurement of sensor 60. Further, a cooling roller, not shown, may be provided to solidify the ink-layer 90 or an electronic refrigeration elements employing the Peltier effect may be used for cooling the ink-roller 34. Flanges may be provided on both sides of the reforming roller 46 so that the ink of the ink-molten pool 52 does not flow over the sides of the reforming roller 46.

Referring to Fig. 5, another embodiment comprises an endless belt 100 as an ink-carrier, the endless belt 100 running around a drive pulley 96 and a driven pulley 98. The endless belt 100 is made of a heat-resistant rubber or a synthetic resin. Preferably, a timing belt 104 (see Fig. 6) with interior teeth 102 inside is employed with corresponding teeth formed on the drive pulley 96, the driven pulley 98 and an idling pulley 106. Thus, the endless belt can be fed exactly in accordance with the rotation of drive pulley 96 (see arrow 108) and driven pulley 98 (see arrow 110). Of course, the endless belt may be flat.

When the ink-layer 90 is formed, the temperature of the ink-molten pool 52 is higher than the melting point of ink. The temperature of the ink must be lowered to solidify the ink-layer 90 before the ink-layer 90 comes in contact with the thermal head 66. The printing paper will be spotted and the printing quality be degraded if the ink on the roller 90 has not been completely solidified. To prevent the degradation of printing quality, the ink-layer 90 is solidified by cooling the ink-roller 34 by the fan 64 in the embodiment described above with reference to Fig. 2. In that embodiment, however, the distance from the ink-molten pool 52 to the thermal head 66 can be prolonged only by enlarging the diameter of ink-roller 34 or a fan with a larger air flow must be employed to solidify the ink-layer completely, thus enlarging the dimensions of the device. In the embodiment of Fig. 5, the endless belt 100 replaces the ink-roller 34 to assure a sufficient cooling distance to solidify the ink-layer 90. Thus, temperature control of endless belt 100 can be achieved without difficulty and printing quality can be improved by ensuring solidification of the ink-layer 90. The processes of forming and reforming the ink-layer 90 and printing function are the same as the embodiment of Fig. 2; accordingly, a description of these processes is omitted.

In the above embodiments described with reference to the drawings, the thermal head is employed for generating thermal patterns to melt the ink-layer. However, heat ray sources such as a laser beam or beams, LED arrays and a tungsten-filament lamp may be used for generating thermal patterns which are improved in respect of resolution of picture elements, printing speed and multi-colour printing, and details of which will be described hereinunder. In Fig. 7 is shown an embodiment in which a laser beam is adopted for generating thermal patterns. In this Figure, a laser beam source 112 is provided for melting the ink-layer 90 and scanning means 114 are provided for scanning the laser beam. A lens system 116 is provided which comprises a collimating lens for obtaining a minute beam spot, a converging lens for converging the beam, and a scanning lens for correcting the deflection. Means 118 are provided for making the laser beam parallel which are provided for ensuring that the laser beam is perpendicular to all printing positions, since the angle of incidence of the laser beam to pressing means 120 differs in accordance with printing position if the laser beam is scanned by scanning means 114 only in the axial direction of ink-roller 34. Pressing means 120 for the printing paper are included, and are made of heat ray permeable glass such as cold mirror or SELFOC lens array or glass fiber bundle, and are attached to a rotatable support means 122. The pressing means 120 are provided for pressing the printing paper 62 against the ink-layer 90 around the ink-roller 34. The pressing means 120 fall in the direction of the arrow 124 when printing is not effected, but rotate in the counterwise direction shown by the arrow 124 to press the paper against the ink-layer 90 when the printing signal or predicting signal is received.

In operation, the ink-roller 34 is rotated in the direction of the arrow 80 by the drive motor 42 before the printing signal is received and thus an ink-layer 90 is formed on the surface of ink-roller 34. The drive motor 42 and the ink-roller 34 stop when the printing signal is fed to the device and then the laser beam is emitted from the laser beam source 112. The laser beam is reflected by the scanning means 114 and, converged by the lens system 116, arrives at beam adjusting means 118. The laser beam is adjusted by the means 118 so that the beam is perpendicular to the ink-roller 34 at all printing positions. Next, the laser beam reaches the ink-layer 90 through pressing means 120 and printing paper 62. The ink of the exposed portion of the ink-layer 90 melts and the melted ink adheres onto the printing paper 62 in dots. At the same time, the printing paper 62 is pressed against the ink-layer 90 by the pressing means 120, thus transferring the ink completely onto the printing paper 62. The pressing means is, as described before, permeable by the beam so that the laser beam can pass freely through the pressing means 120, which will not be heated by the beam.

A line of dots is printed by scanning the laser beam in the axial direction of ink-roller 34 by scanning means 114. The detailed construction of the scanning means 114 will next be described with reference to Fig. 8. The scanning means 114 comprise a rotatable mirror 128 with a plurality of mirror surfaces 126 and a motor 132 by which the mirror 128 is rotated in the direction of the arrow 130. The mirror surface 126 on which the beam from the laser beam source 112 is incident, reflects the laser beam in order to scan the beam from points 134 to 136 on the paper 62. In other words, each mirror surface 126 scans the laser beam from points 134 to 136 once as the mirror 128 is rotated by the motor in one revolution. When the printing of a line of dots is finished, the printing paper 62 is fed by one step by the paper feed roller 74 in the direction of the arrow 80 and the laser beam is restored to its original position 134 by scanning means 114. These steps are repeated in succession for printing. There may be provided means for modulating the laser output, for example to control directly the discharge current of laser beam source 112 or by use of an ultrasonic modulator. The printing speed may be increased by providing a plurality of laser beam sources 112 along the axial direction of ink-roller 34.

Referring now to Fig. 9, an embodiment is shown in which a plurality of ink-rollers 34 are provided along the feed direction of printing paper 62 for multi-colour printing. In the embodiment, the colours of each ink-layer 90 is different from the colour of the others and the position control of dots of different colours is achieved by spacing the ink-rollers apart by a distance which is a multiple of the line step and is in synchronism with the pulse motor 78. For multi-colour printing, three primary coloured inks of magenta, cyanic and yellow are used and they are heated and mixed by the heater 138 which is provided on the way of feeding direction of printing paper 62. In this case, the temperature of the heater 138 may be set a little higher than the melting point.

In the embodiments described above with reference to Figs. 2 to 9, heat emanates from the outside of ink-roller

34. However, an LED array 140 forming a heat ray source may be provided inside the ink-roller 34 as shown in Fig. 10. The cylindrical ink-roller 34 consists of a heat ray permeable material such as a cold mirror and the printing paper 62 is introduced between the ink-roller 34 and platen 142. The LED array 140 inside the ink-roller 34 emanates beams in the direction of the arrow 144 to heat the ink-layer 190 on the surface of ink-roller 34, thereby, the ink melts and is transcribed onto the printing paper 62.

An endless belt 100 may be used as shown in Figs. 11 and 12 in place of ink-roller 34 and the laser beam may be emitted from the in-or outside of the endless belt 100. The endless belt 100 may be a timing belt with teeth or it may consist of sheet or film of rubber, synthetic resin or glass fibre.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings and it is therefore understood that within the scope of the invention, the concept may be practised otherwise than specifically described.

CLAIMS

1. A thermal printing device of the kind for printing on ordinary paper using an ink which melts when heated but which is solid at room temperatures, and comprising an ink-carrier having an outer surface for carrying an ink-layer on said surface from a source of ink to a printing position, a cylindrical roller in contact with said outer surface to form a location for said source of ink therebetween, means for melting the ink in the source of ink, means for moving the ink-carrier so that the melted ink forms an ink-layer on the ink-carrier, thermal pattern generating means at said printing position for remelting a solid ink-layer on the surface of the ink-carrier by generating thermal patterns in accordance with printing signals fed thereto, and printing paper control means for controlling the feeding of printing paper and for forcing the printing paper into contact with the ink-carrier so that ink patterns produced by the thermal pattern generating means are transcribed onto the printing paper, characterised in that the outer surface of the ink-carrier (34,100) is even, that the cylindrical roller (46) has an uneven outer surface (48) in directions parallel to the axis of the roller and in that said uneven outer surface (48) contacts the outer surface of the ink-carrier (34,100) along lines spaced apart across the width of the roller.

2. A thermal printing device according to claim 1 characterised in that said cylindrical roller (46) comprises a cylindrical body (92) and an electric resistance

wire (50) which is provided inside said cylindrical body for melting the ink of the ink source on the application of an electric voltage to said electric resistance wire.

3. A thermal printing device according to claim 1 or claim 2 characterised in that said cylindrical roller (46) comprises a cylindrical body (92) and wires (48) which are closely wound around the surface of said cylindrical body to form said uneven surface.

4. A thermal printing device according to claim 1 characterised in that said cylindrical roller comprises a cylindrical body (92) and an electric resistance wire which is closely wound around the surface of said cylindrical body for melting the ink of the ink source on the application of an electric voltage to said electric resistance wire and to form said uneven surface.

5. A thermal printing device according to any one of claims 1 to 3 characterised in that said ink-carrier (34) is formed by a cylindrical roller of an elastic material.

6. A thermal printing device according to any one of claims 1 to 3, characterised in that said ink-carrier (100) is formed by an endless belt of an elastic material.

7. A thermal printing device according to any one of claims 1 to 5 characterised in that said thermal pattern generating means (60) comprise a set of electric resistance elements which generate heat on application of an electric

voltage.

8. A thermal printing device according to any one of claims 1 to 5 characterised in that said heat pattern generating means (66) comprise a source of heat rays (112, 140).

FIG. 1

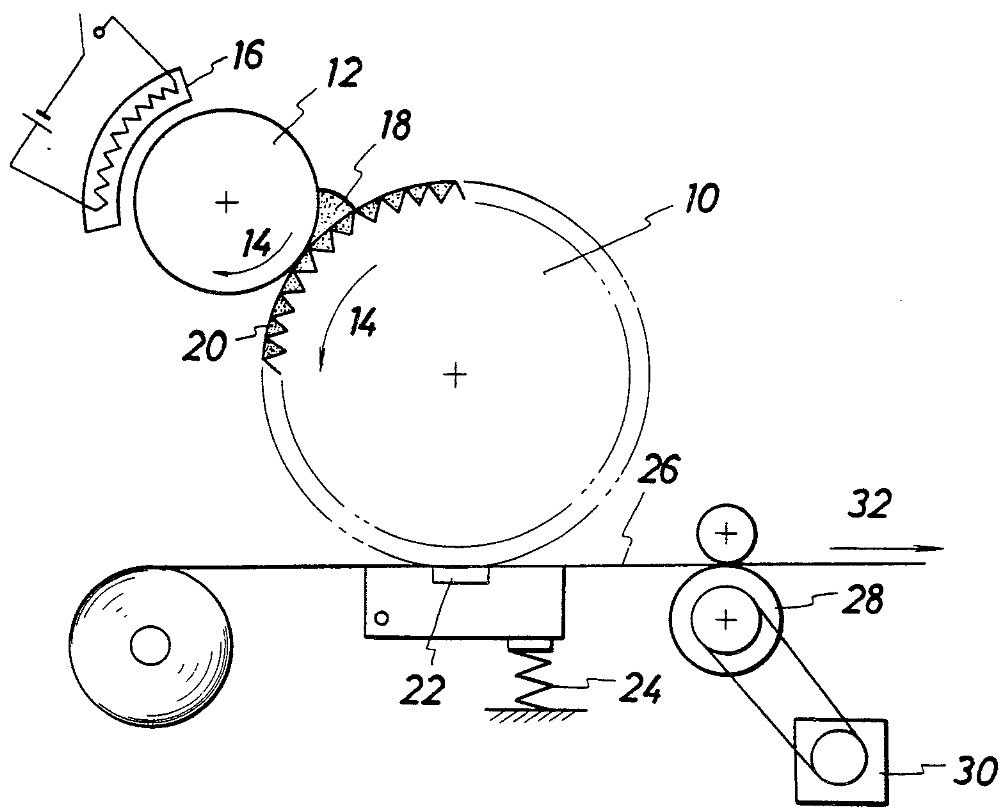

FIG. 2

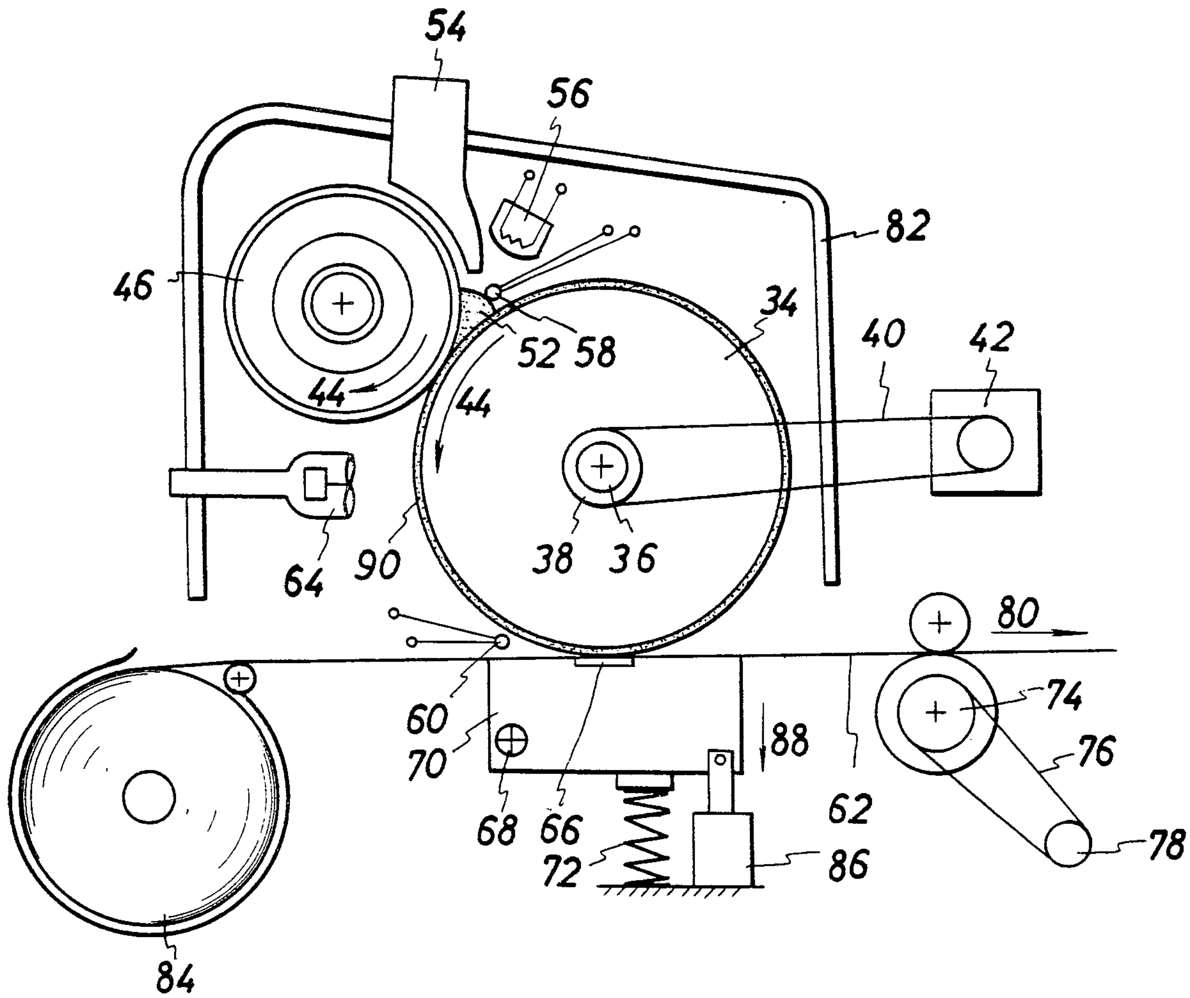
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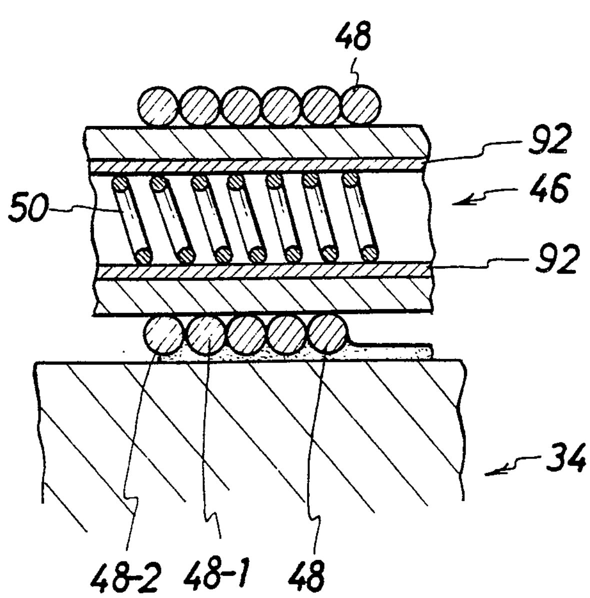
FIG. 3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46
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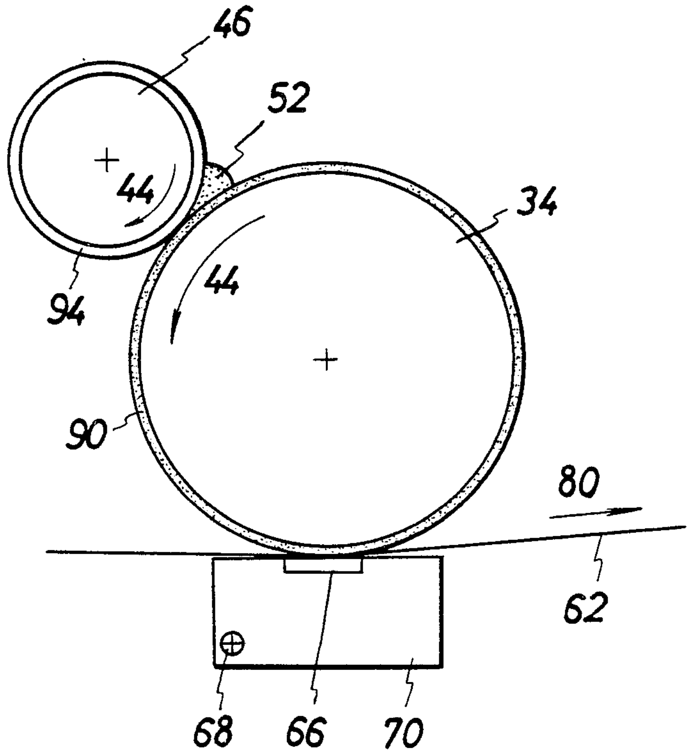
48-1
48

FIG. 4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52
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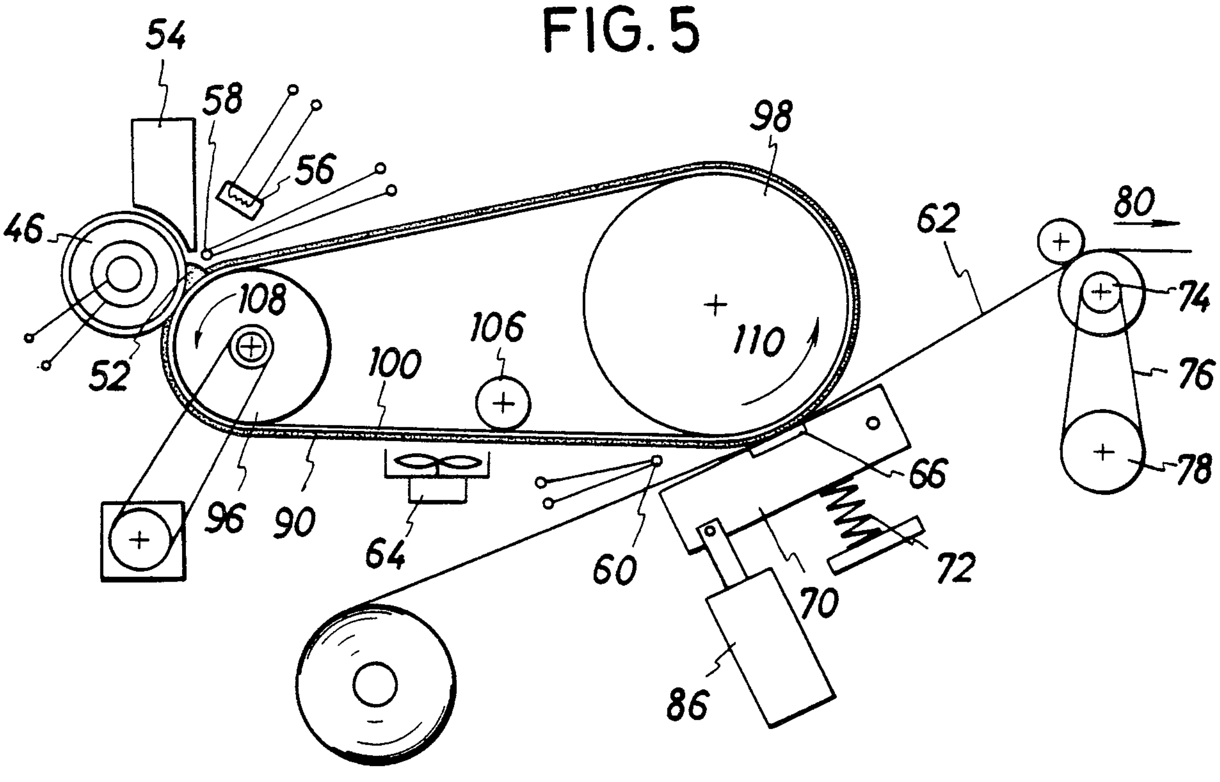
34
44
94
90
80
62
68
66
70

FIG. 5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74
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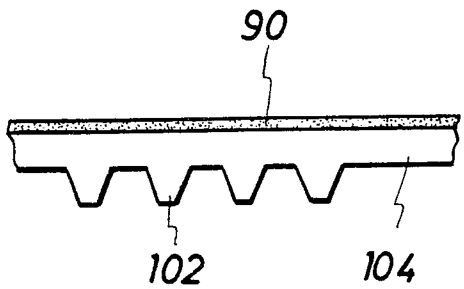
70
86

FIG. 6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102
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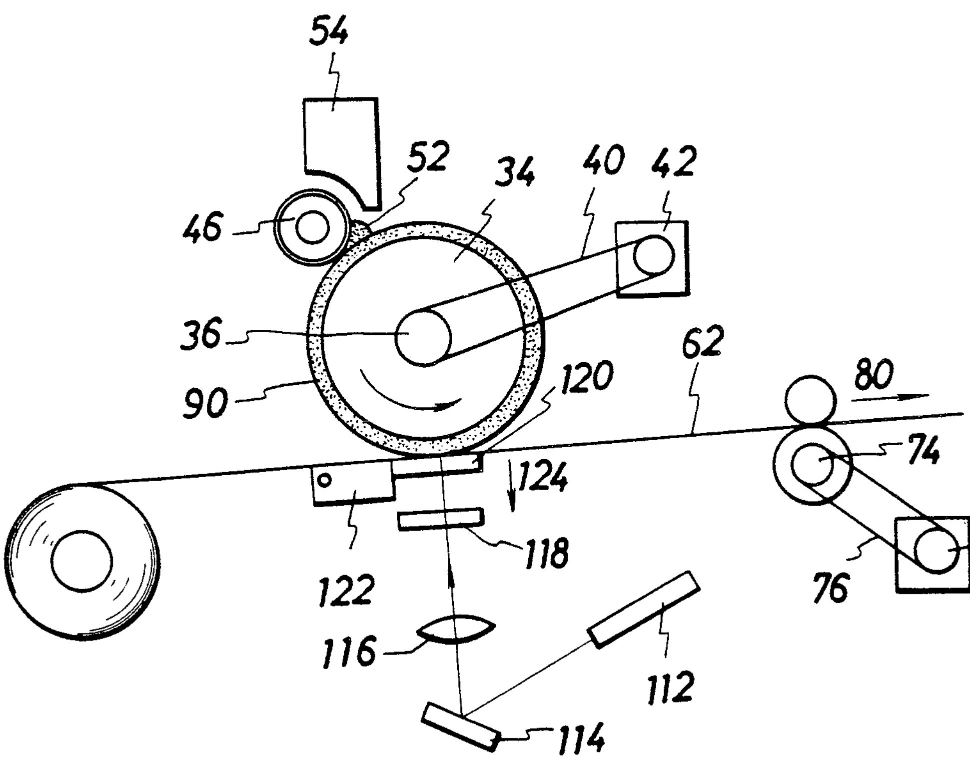
FIG. 7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80
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124
122
118
78
76
116
112
114

FIG. 8

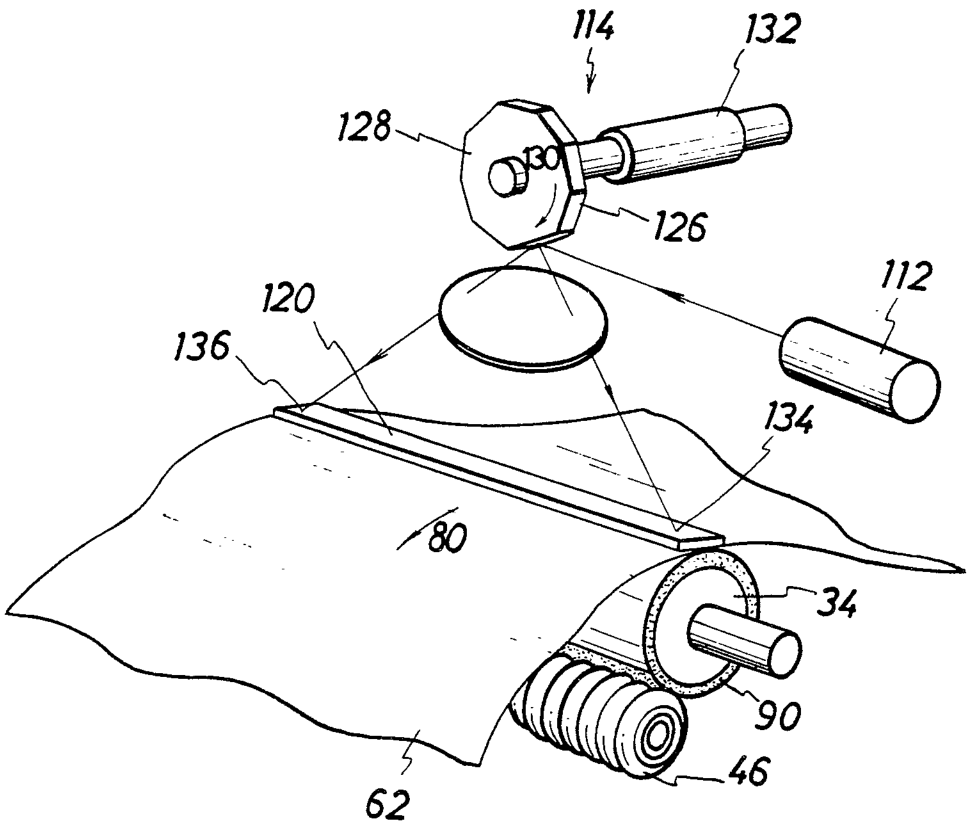
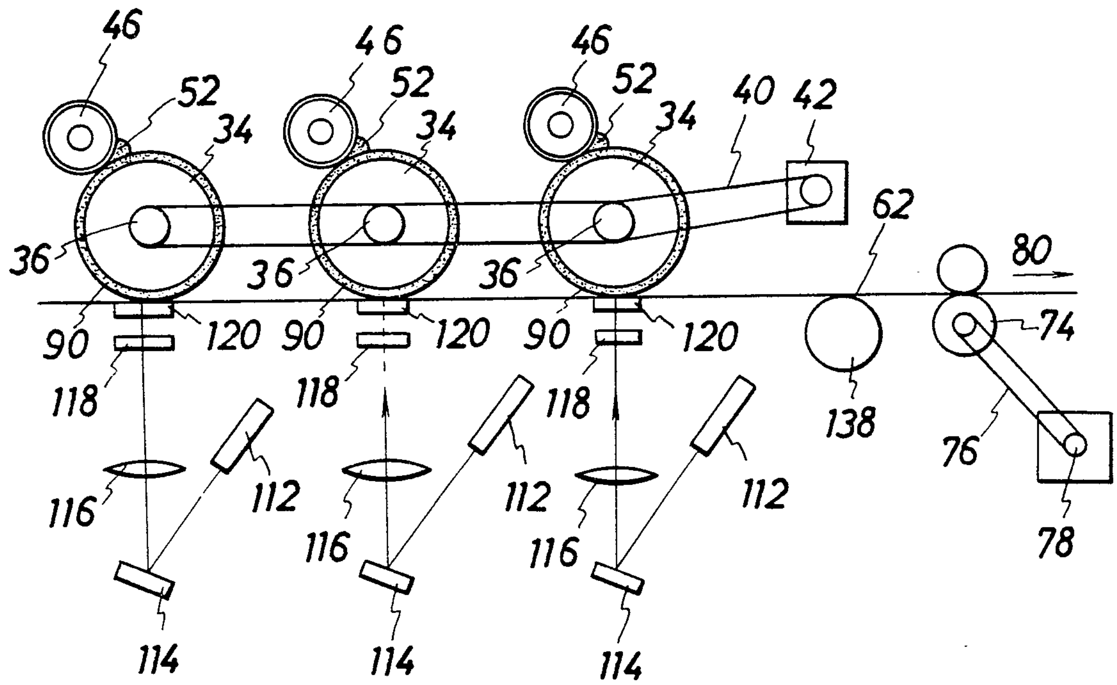


FIG. 9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120
74
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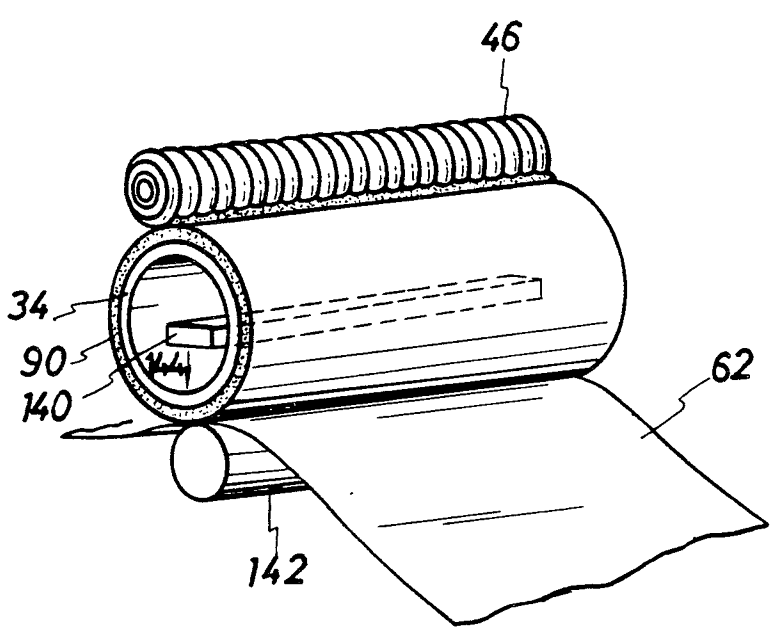
118
118
138
76
112
112
112
116
116
116
78
114
114
114

FIG. 10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62
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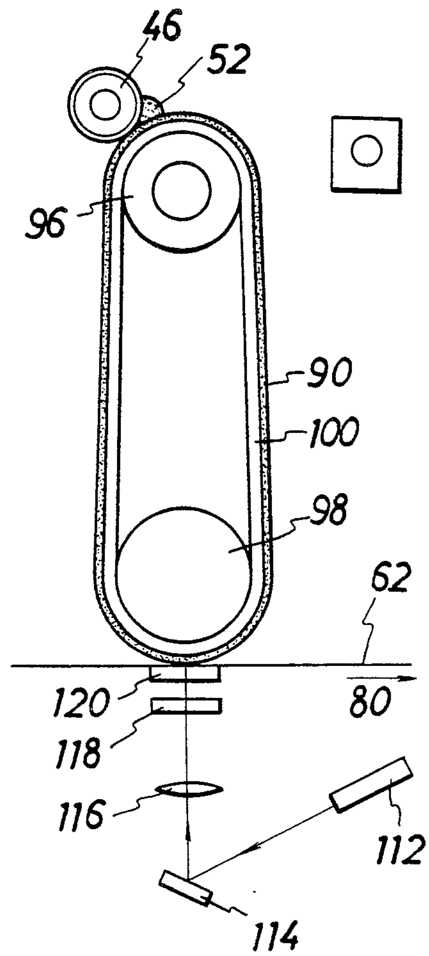
FIG.11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52
96
90
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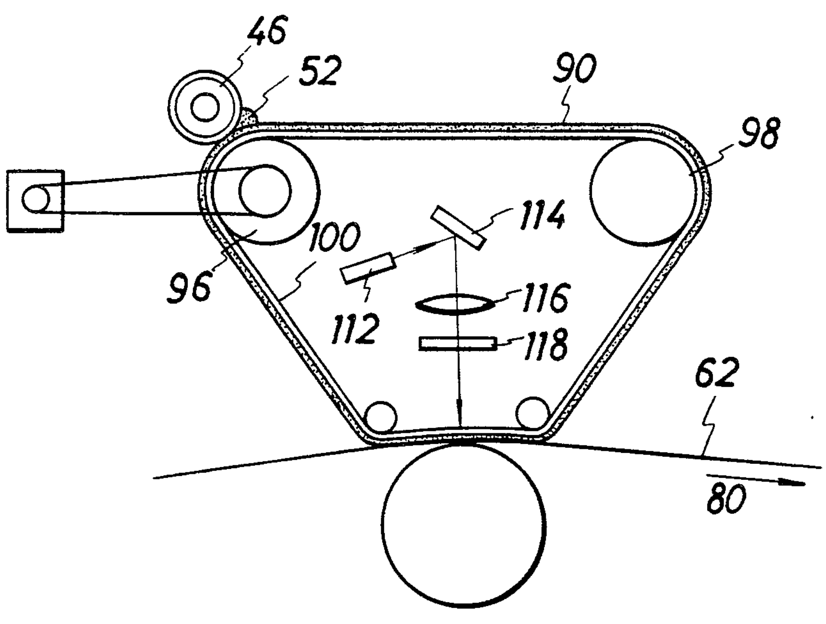
98
62
120
80
118
116
112
114

FIG.12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80